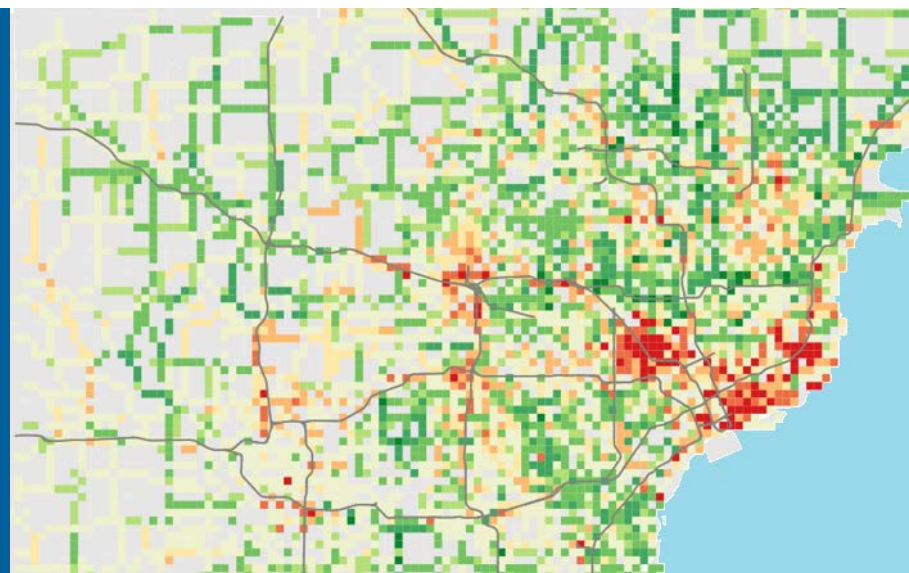Argonne
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Impact of Population Shift on Energy Use: Detroit Use Case

JOSHUA AULD, MAHMOUD JAVANMARDI, TOM STEPHENS, YAN ZHOU, DOMINIK KARBOWSKI, AYMERIC ROUSSEAU

**2017 DOE Hydrogen Program and Vehicle Technologies
Annual Merit Review**

June 8, 2017

Project Overview

Timeline	Barriers
• Project start date : Nov. 2015 • Project end date : Dec. 2016 • Percent complete : 100%	• Disparate simulation models • No process for utilizing multiple data sources • Energy analysis requires individual level vehicle forecasts

Budget	Partners
• FY16 Funding: $200k • FY17 Funding: $0	• Argonne (Lead) • City of Detroit • Southeast Michigan Council of Governments (SEMCOG) • Detroit Future City • NREL

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Project Relevance

Quantify the Energy Impact of Population and Land Use Shifts through Combined Transportation System and Vehicle System Simulation

- Objectives:
  - Develop and validate a transportation system model for SE Michigan
  - Design relevant case studies for interested stakeholders
  - Evaluate energy and mobility impacts of various cases

- Focus of case study on population, employment increases
  - Key goal of the city
  - Aligned with Detroit Future City scenarios
  - *With a focus on energy*

- Interaction with DOE VTO BaSce vehicle technology forecasts
  - What impact do population and land use changes have on the efficacy of the vehicle technology program?


3

Approach

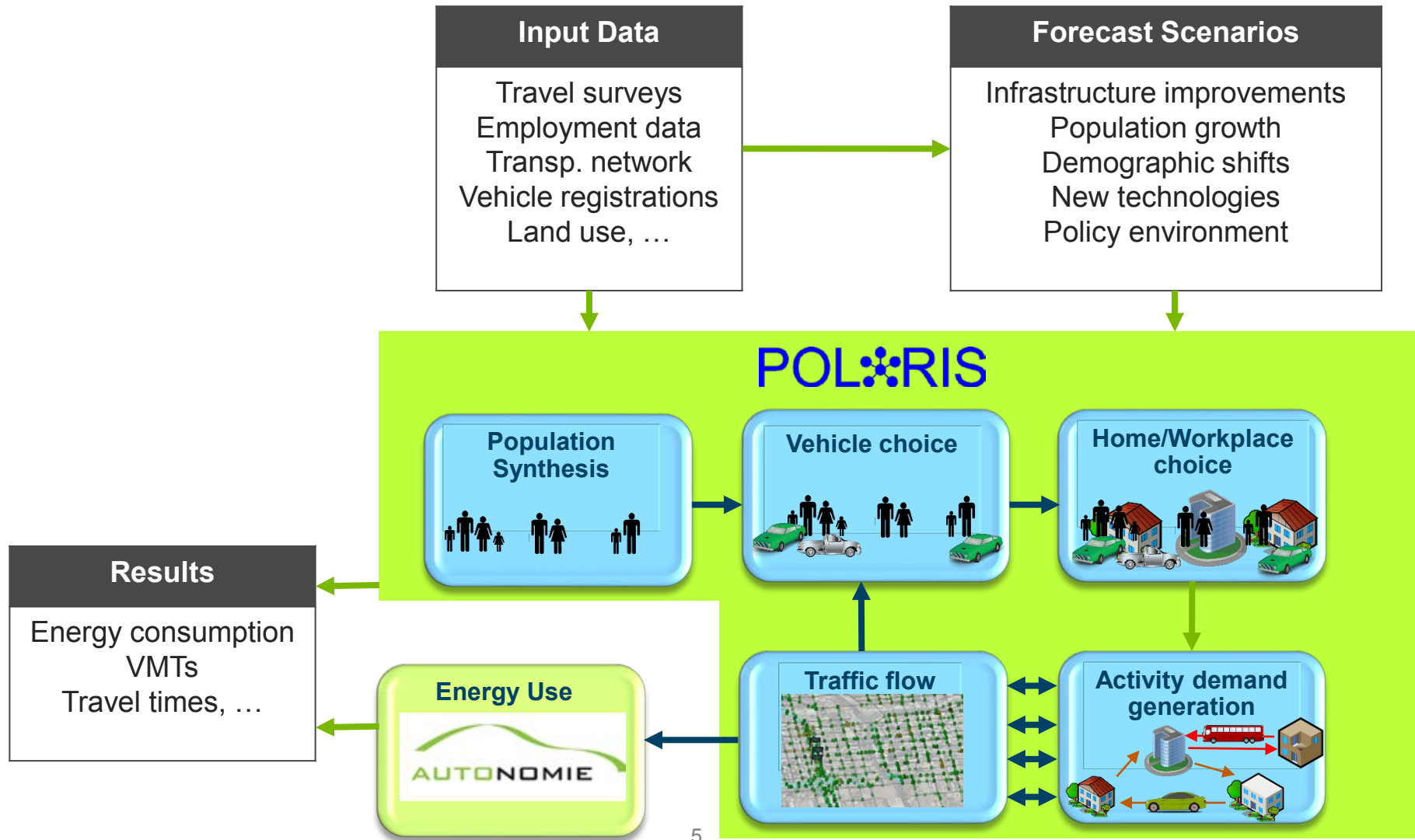## Modeling in POLARIS, a Tool Uniquely Designed to Study Complex Transportation Systems
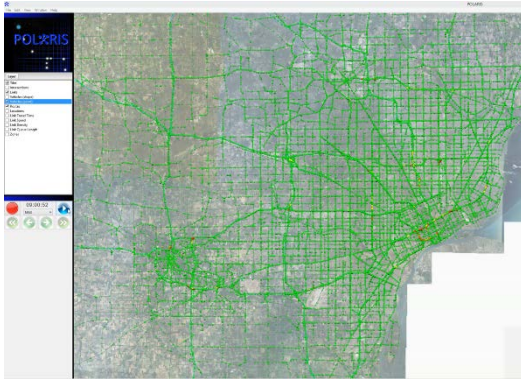
- POLARIS allows to run large-scale studies:
  - Written in C++, multi-threading, designed for **HPC**
  - Detroit model ≈ 4M travelers ≈ 18M trips (per day) ≈ 1.5h simulation time (vs several days for other tools)

- POLARIS is **open-source**, with a dedicated team of developers and transportation experts at Argonne

- POLARIS is designed from the ground-up to accommodate traveler behavior, transportation network operations and vehicle technology:
  - *Agent-based: each traveler is modeled individually, has specific behavior and adjust behavior to transportation supply*
  - *Activity-based: travel demand is derived from modeled activities (work, school, leisure, etc.)*
  - *Integrated: demand (e.g. origin/destination) and supply (routing, traffic flow) are integrated in the same platform, allowing direct interactions (e.g. replanning/rerouting in case of unusual travel time)*
  - *Energy: POLARIS + Autonomie outputs energy consumption in the context of evolving vehicle powertrain technologies*
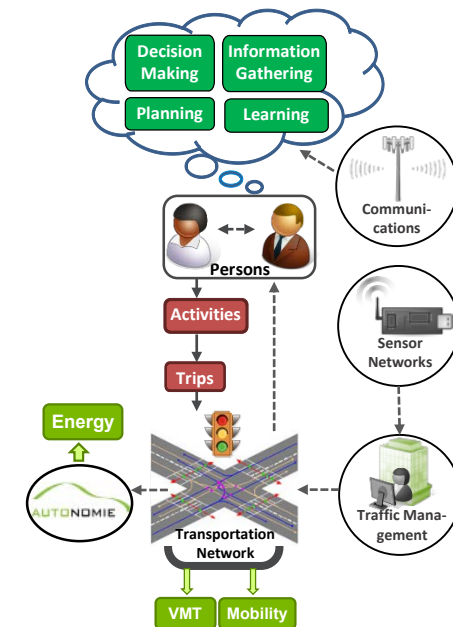
Approach

Collect Data and Scenarios from Stakeholders to Build Physical Models and Update Polaris Components as Needed

Input Data
- Travel surveys
- Employment data
- Transp. network
- Vehicle registrations
- Land use, …

Forecast Scenarios
- Infrastructure improvements
- Population growth
- Demographic shifts
- New technologies
- Policy environment

POL✱RIS

Population Synthesis

Vehicle choice

Home/Workplace choice

Results
- Energy consumption
- VMTs
- Travel times, …

Energy Use
AUTONOMIE

Traffic flow

Activity demand generation

Approach
Estimating Energy Use with POLARIS + Autonomie
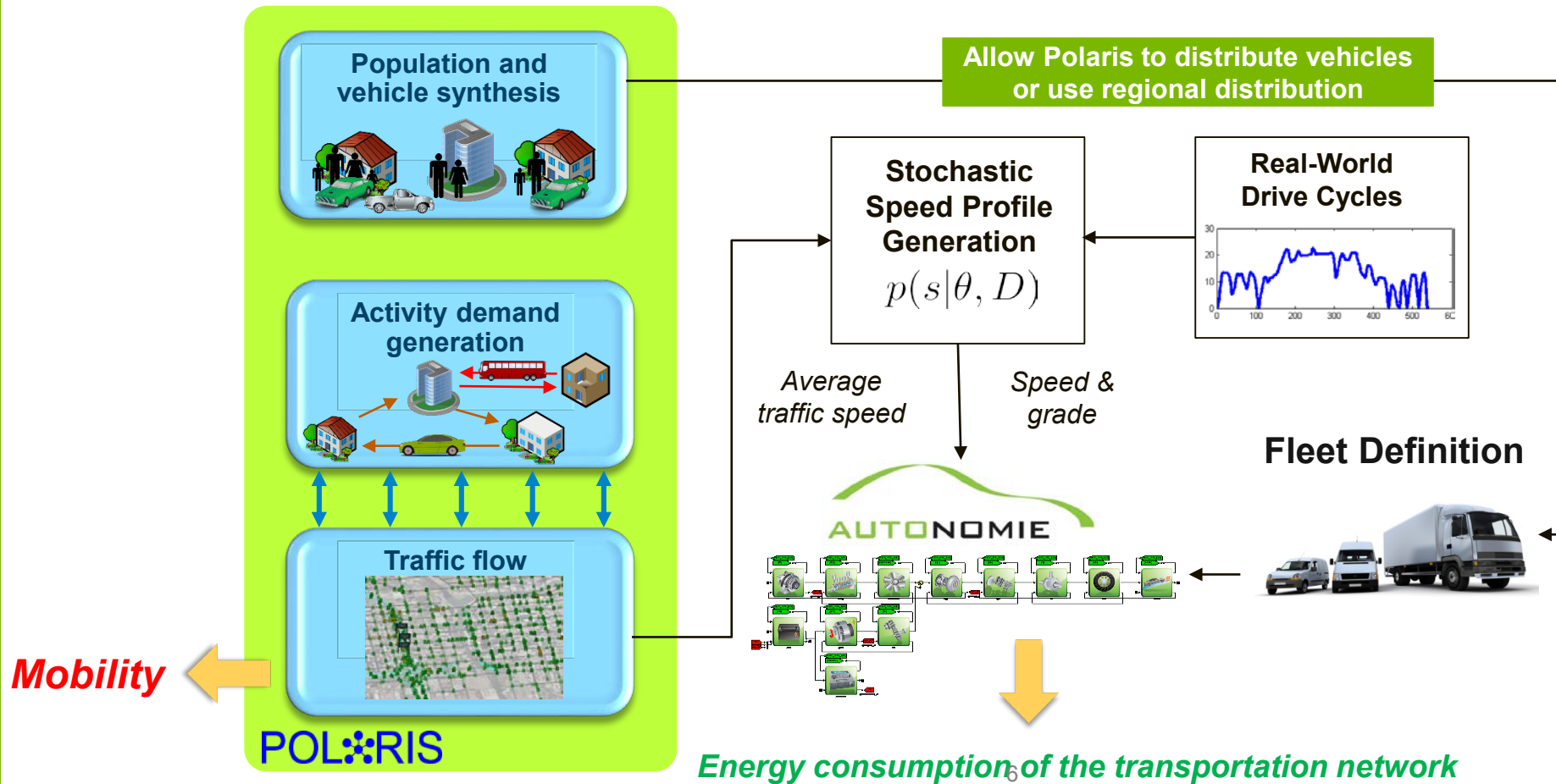
Energy consumption of the transportation network

Milestones

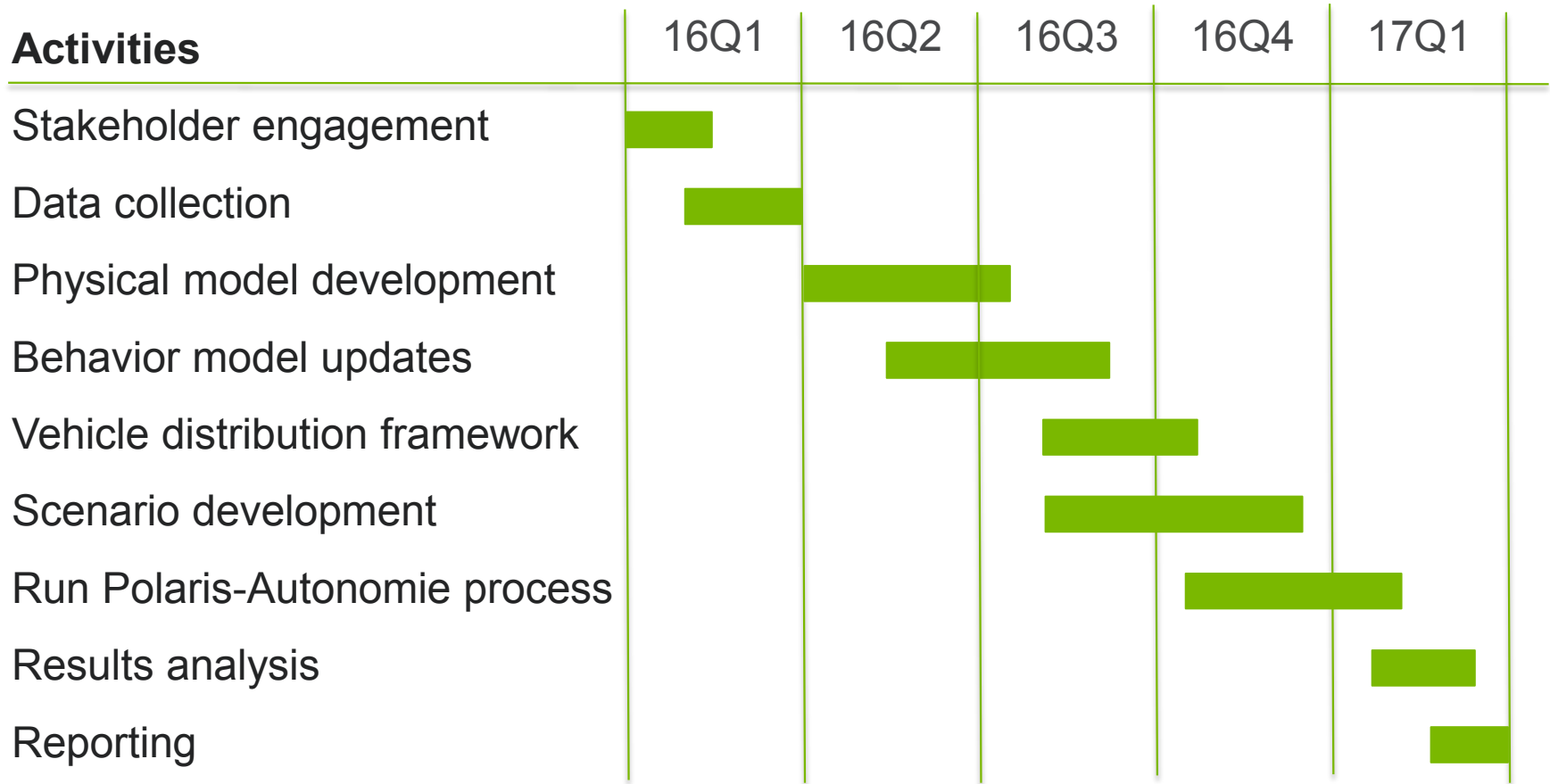| Activities	16Q1	16Q2	16Q3	16Q4	17Q1
Stakeholder engagement	▇				
Data collection	▇				
Physical model development		▇			
Behavior model updates		▇			
Vehicle distribution framework			▇		
Scenario development			▇		
Run Polaris-Autonomie process				▇	
Results analysis					▇
Reporting					▇

Argonne
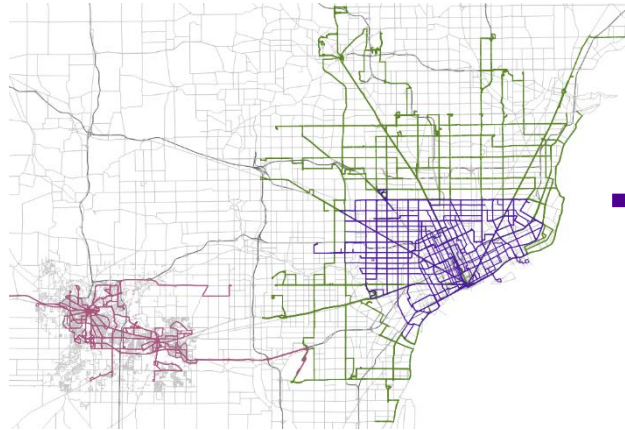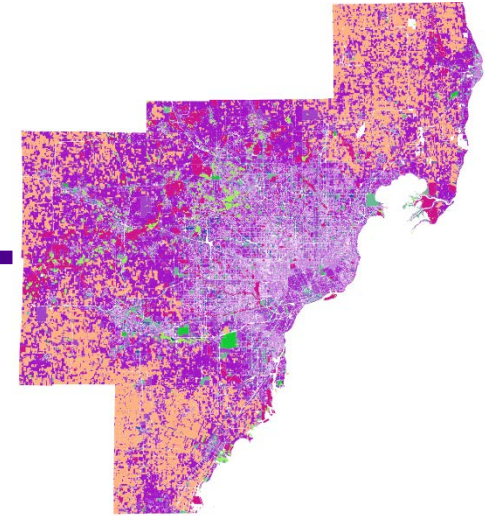NATIONAL LABORATORY

Technical Accomplishments

Developed POLARIS Detroit Physical Model from a Variety of Data Sources and Partnerships
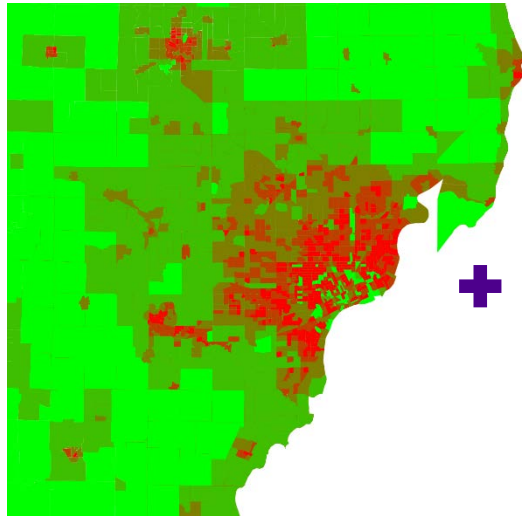
Census

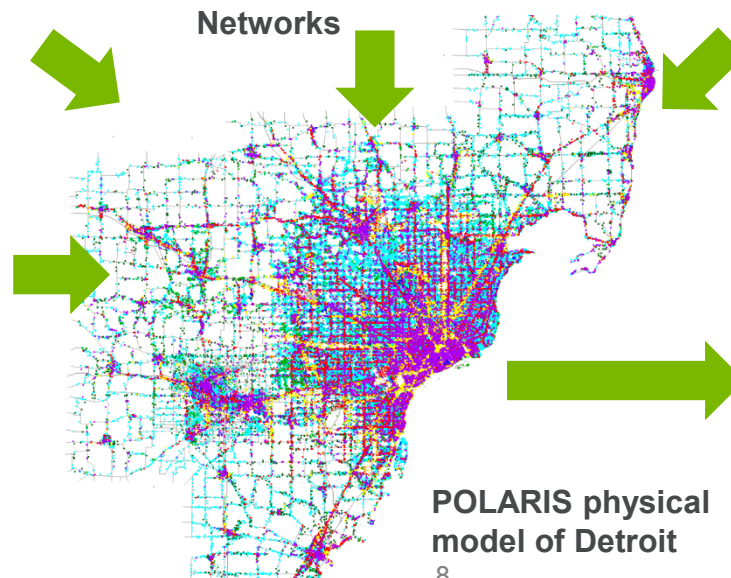**Networks**

Land Use

County Business Patterns

Economic Census

Household Surveys

MPO Travel Model
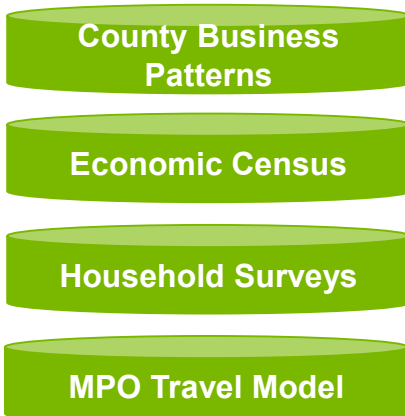
POLARIS physical model of Detroit

8
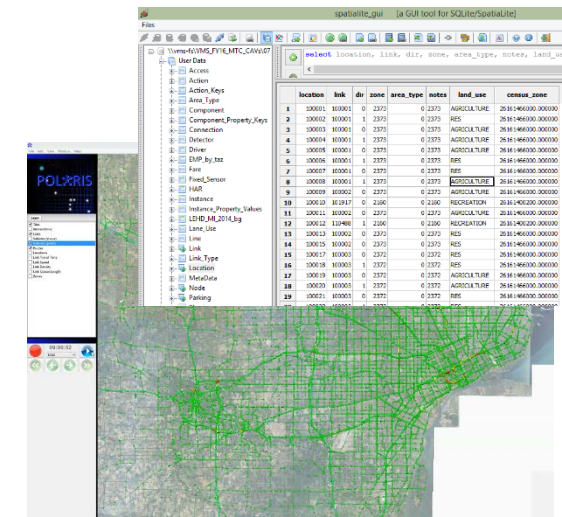
Technical Accomplishments

New POLARIS Behavioral Mode Choice Model Developed for Detroit

- Discrete choice model with many significant policy variables, e.g. cost, travel time, density, veh. availability

- Estimated from SEMCOG household travel survey

- Nested structure between:
  - Auto modes (drive, pass, taxi)
  - Transit
  - Non-motorized (walk, bike)

- Applied at the tour level:
  - Choice of mode for main activity constrains trip-level mode choice
  - Three tour types – work, other, out of home sub-tour

- Good fit-statistics:
  - $\rho^2 = 0.68$
  - accuracy = 73%
  - F1 = 0.262

County Mode Distribution by Purpose
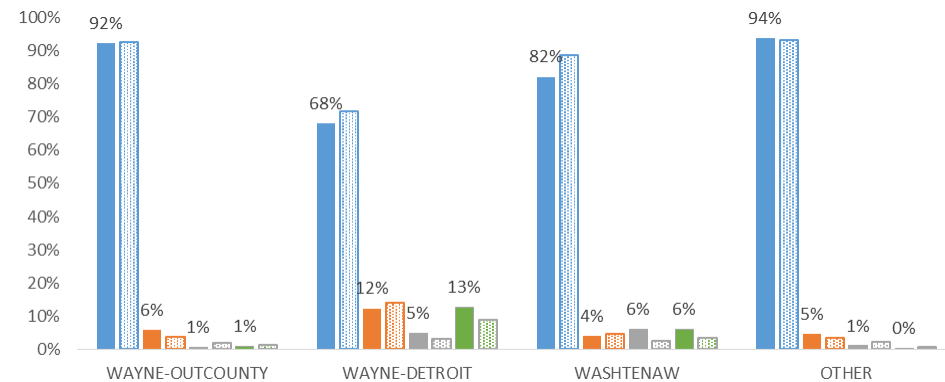
Home-based work
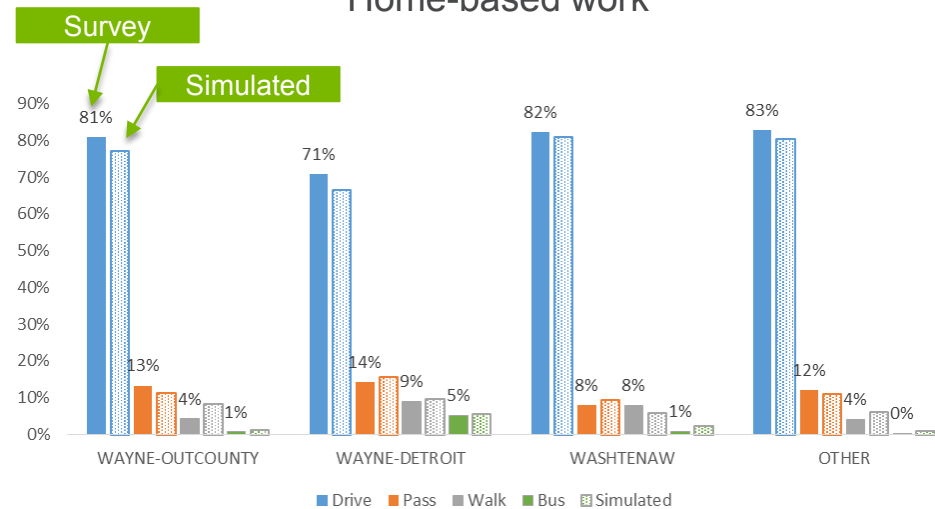
Home-based other

Technical Accomplishments

Vehicle Registration Data was Used to Distribute Vehicle Types to Households through a New Vehicle Choice Framework

Source: IHS Automotive vehicle registration data and Census 2010

POLARIS has been updated to simulate individual vehicles and allow household members to select vehicles for trips

The process to use registration data is a placeholder for more advanced vehicle choice modeling under development

% HEV
- <0.5%
- 0.5% - 1.0%
- 1.0% - 2.5%
- >2.5%

% PEV
- < 0.1%
- 0.1 - 0.3%
- 0.3% - 0.7%
- > 0.7%

% SUV/Truck
- <50%
- 50 - 55%
- 55% - 60%
- >60%

% 0-vehicle HH
- <5%
- 5-15%
- 15-25%
- 25-50%
- >50%

Detroit Area Vehicle Registrations by Zip Code
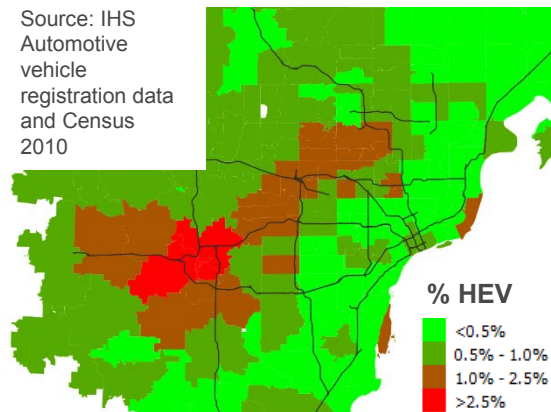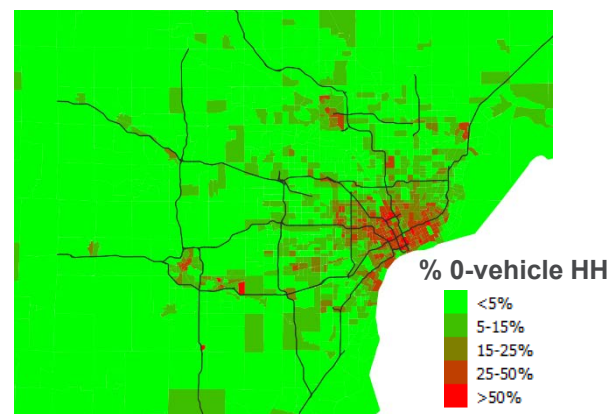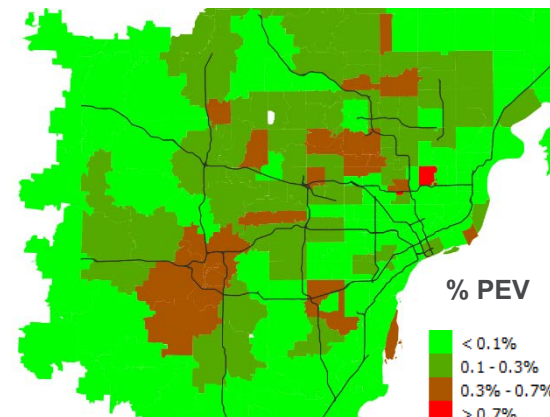As of December 31st 2015

STATE_NAME	ZIP_CODE	MAKE	MODEL	FUEL_TYPE	SEGMENT
MICHIGAN	48141	FORD	TAURUS	GAS	NON LUXURY TRADITIONAL FU
MICHIGAN	4843C	FORD	BRONCO	GAS	NON LUXURY FULL SIZE SUV
MICHIGAN	48055	FORD	ESCAPE	GAS	NON LUXURY COMPACT CUV
MICHIGAN	48135	FORD	EXPLORER	GAS	NON LUXURY MID SIZE SUV
MICHIGAN	48034	FORD	FOCUS	GAS	NON LUXURY TRADITIONAL CO
MICHIGAN	48306	FORD	ESCAPE	GAS	NON LUXURY COMPACT CUV
MICHIGAN	48223	FORD	TAURUS	GAS	NON LUXURY TRADITIONAL FU
MICHIGAN	48085	FORD	FOCUS	GAS	NON LUXURY TRADITIONAL CO
MICHIGAN	48442	FORD	ESCAPE	GAS	NON LUXURY COMPACT CUV
MICHIGAN	48165	FORD	ESCORT	GAS	NON LUXURY TRADITIONAL CO
MICHIGAN	48190	FORD	TAURUS	GAS	NON LUXURY TRADITIONAL FU
MICHIGAN	48227	FORD	MUSTANG	GAS	NON LUXURY SPORT MID SIZE
MICHIGAN	48381	FORD	ESCAPE	GAS	NON LUXURY COMPACT CUV
MICHIGAN	48091	FORD	EXPLORER	GAS	NON LUXURY MID SIZE SUV
MICHIGAN	4820€	DODGE	DURANGO	GAS	NON LUXURY MID SIZE SUV
MICHIGAN	48236	FORD	FIVE HUNDRED	GAS	NON LUXURY TRADITIONAL FU
MICHIGAN	48327	FORD	ECONOLINE	GAS	NON LUXURY FULL SIZE HALF T
MICHIGAN	48092	FORD	TAURUS	GAS	NON LUXURY TRADITIONAL FU
MICHIGAN	48047	FORD	MUSTANG	GAS	NON LUXURY SPORT MID SIZE
MICHIGAN	48182	FORD	ESCAPE	GAS	NON LUXURY COMPACT CUV
MICHIGAN	4884€	DODGE	DURANGO	GAS	NON LUXURY MID SIZE SUV
MICHIGAN	48174	FORD	TAURUS	GAS	NON LUXURY TRADITIONAL FU
MICHIGAN	48237	FORD	ECONOLINE	GAS	NON LUXURY FULL SIZE HALF T
MICHIGAN	48384	FORD	ECONOLINE	GAS	NON LUXURY FULL SIZE HALF T
MICHIGAN	48101	FORD	EXPLORER	FLEXIBLE	NON LUXURY MID SIZE SUV
MICHIGAN	48382	FORD	FOCUS	GAS	NON LUXURY TRADITIONAL CO
MICHIGAN	48122	FORD	ECONOLINE	GAS	NON LUXURY FULL SIZE HALF T
MICHIGAN	49238	DODGE	CARAVAN	FLEXIBLE	NON LUXURY MID SIZE VAN
MICHIGAN	48093	DODGE	CARAVAN	FLEXIBLE	NON LUXURY MID SIZE VAN

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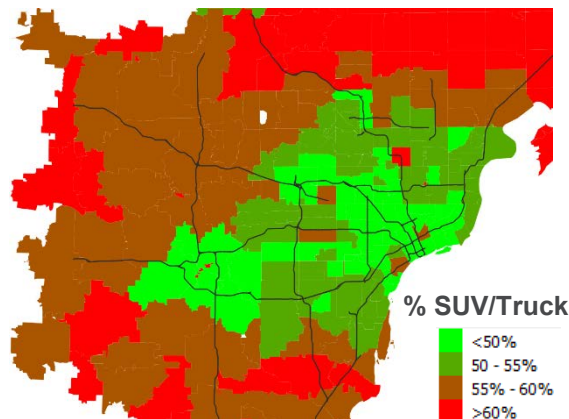
Technical Accomplishments

Used Forecast Inputs from SEMCOG and Land Use Plan from DFC for Scenario Building

Current land use

LAND USE COLOR CODE

- OFFICE
- RESIDENTIAL
- INSTITUTIONAL
- RETAIL
- INDUSTRIAL
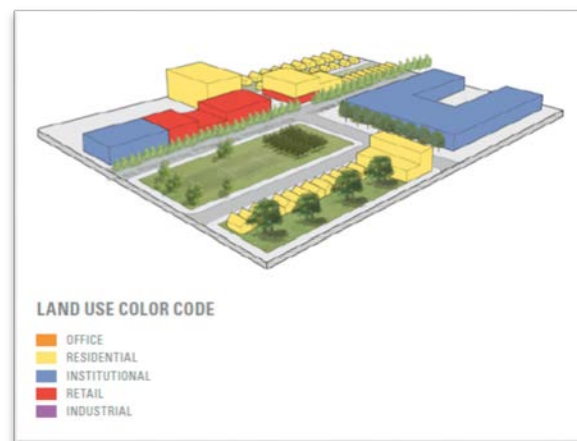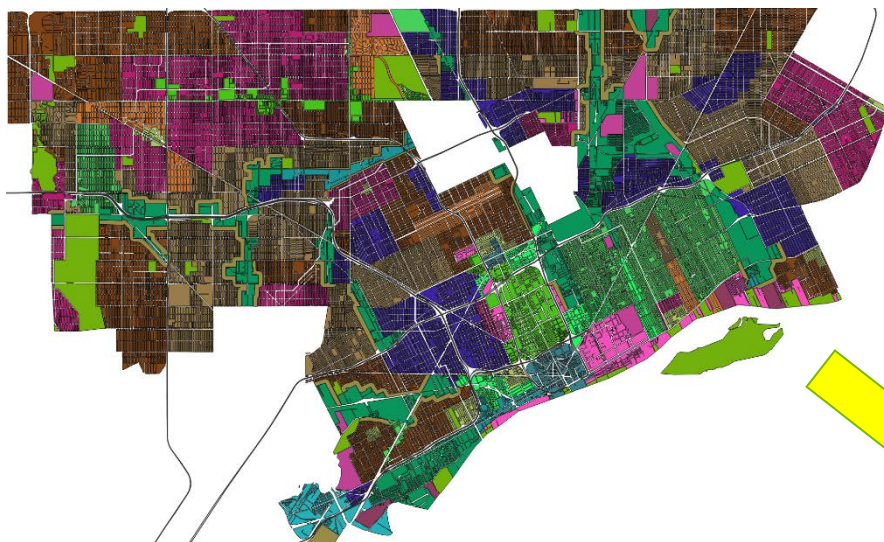
- Future land use influences population, employment and therefore travel intensity
- Changes to how people travel (e.g. transit rider vs. SOV)
- Develop transition probabilities to convert land use changes to new Polaris activity locations
- **Apply regression models to convert new land uses to employment and population forecasts for model input**

Forecast land use

- Medium density residential
- Innovative - Ecological
- Innovative - Productive
- Green Residential
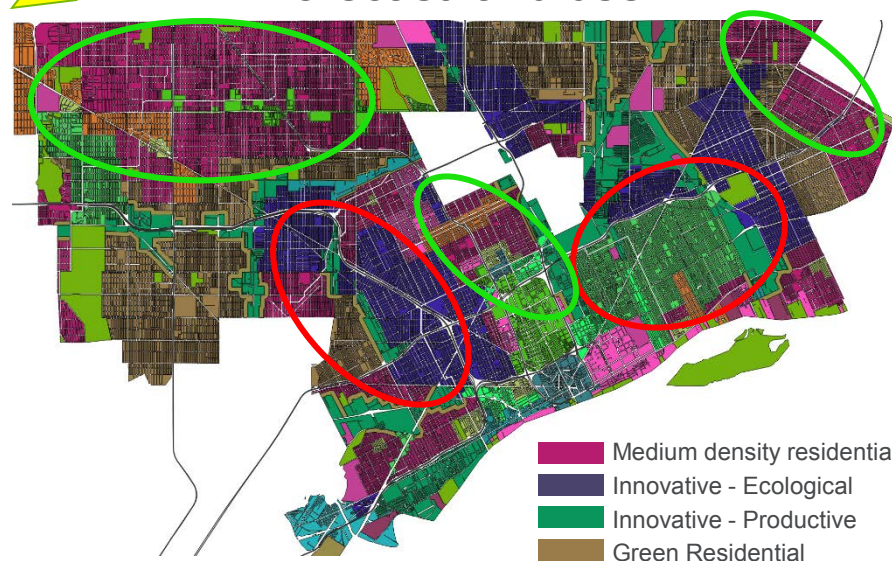
Technical Accomplishments
Population and Employment Forecasted for DFC scenario
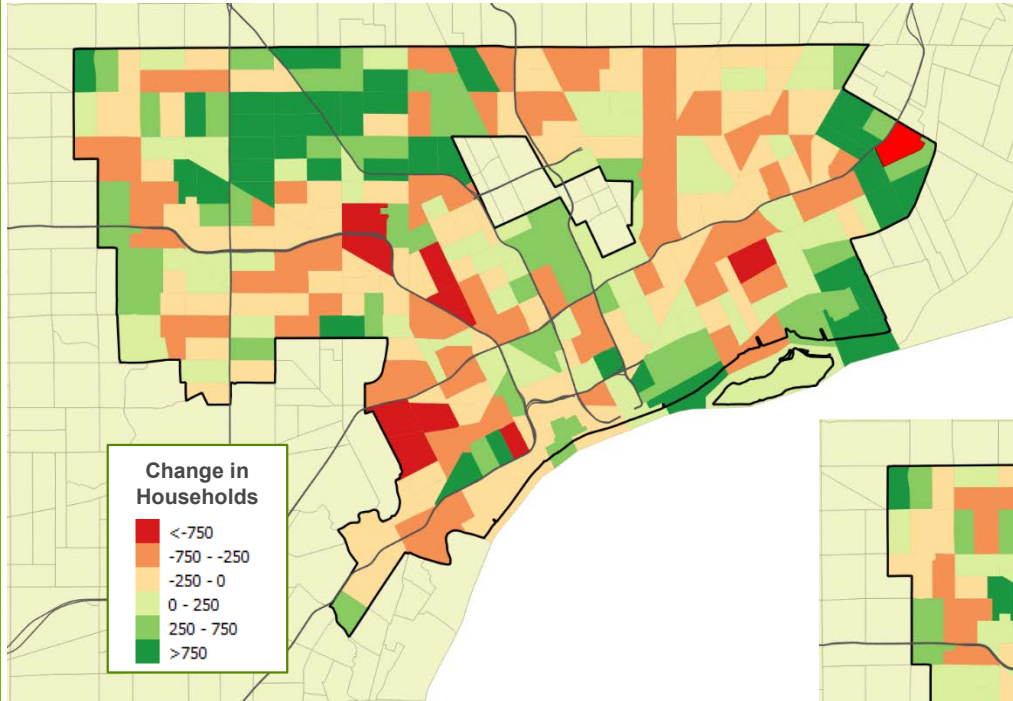
- Two forecast scenarios developed:
  1. SEMCOG 2040: business as usual regional forecast from MP
  2. DFC 2040: use SEMCOG inputs and modify for new land use from DFC plan

	SEMCOG	DFC	Diff.
Pop	615,066	796,369	29%
HH	255,676	360,036	41%
HH size	2.41	2.21	-8%
Employ	354,797	433,018	22%
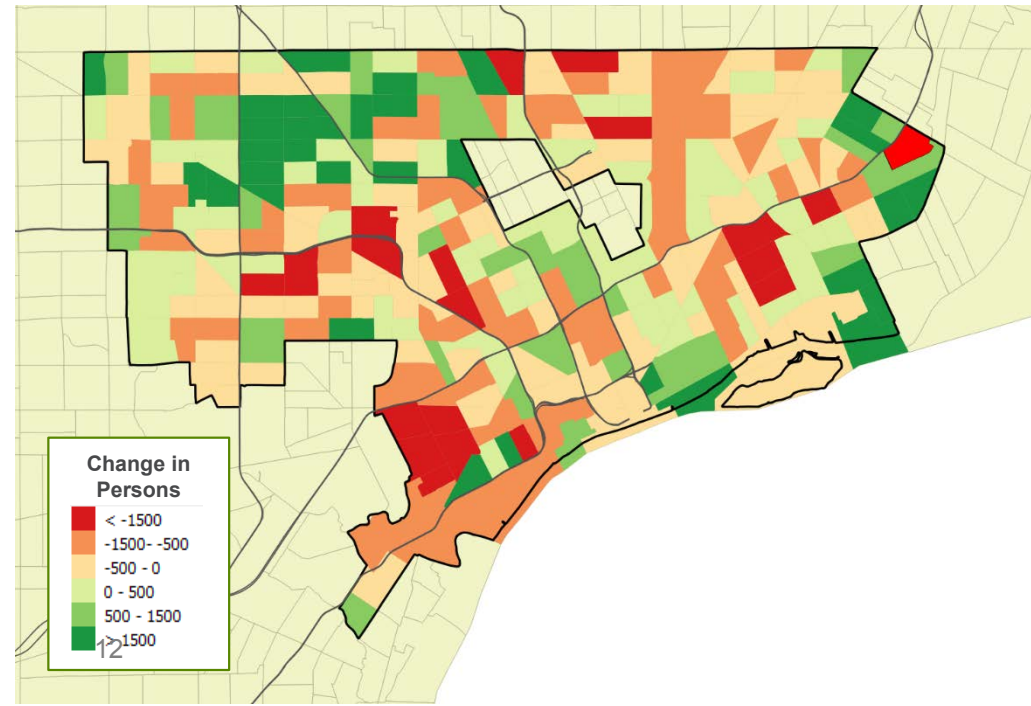
Change in Households
- < -750
- $-750 - -250$
- $-250 - 0$
- $0 - 250$
- $250 - 750$
- > 750

Change in Persons
- < -1500
- $-1500 - -500$
- $-500 - 0$
- $0 - 500$
- $500 - 1500$
- > 1500
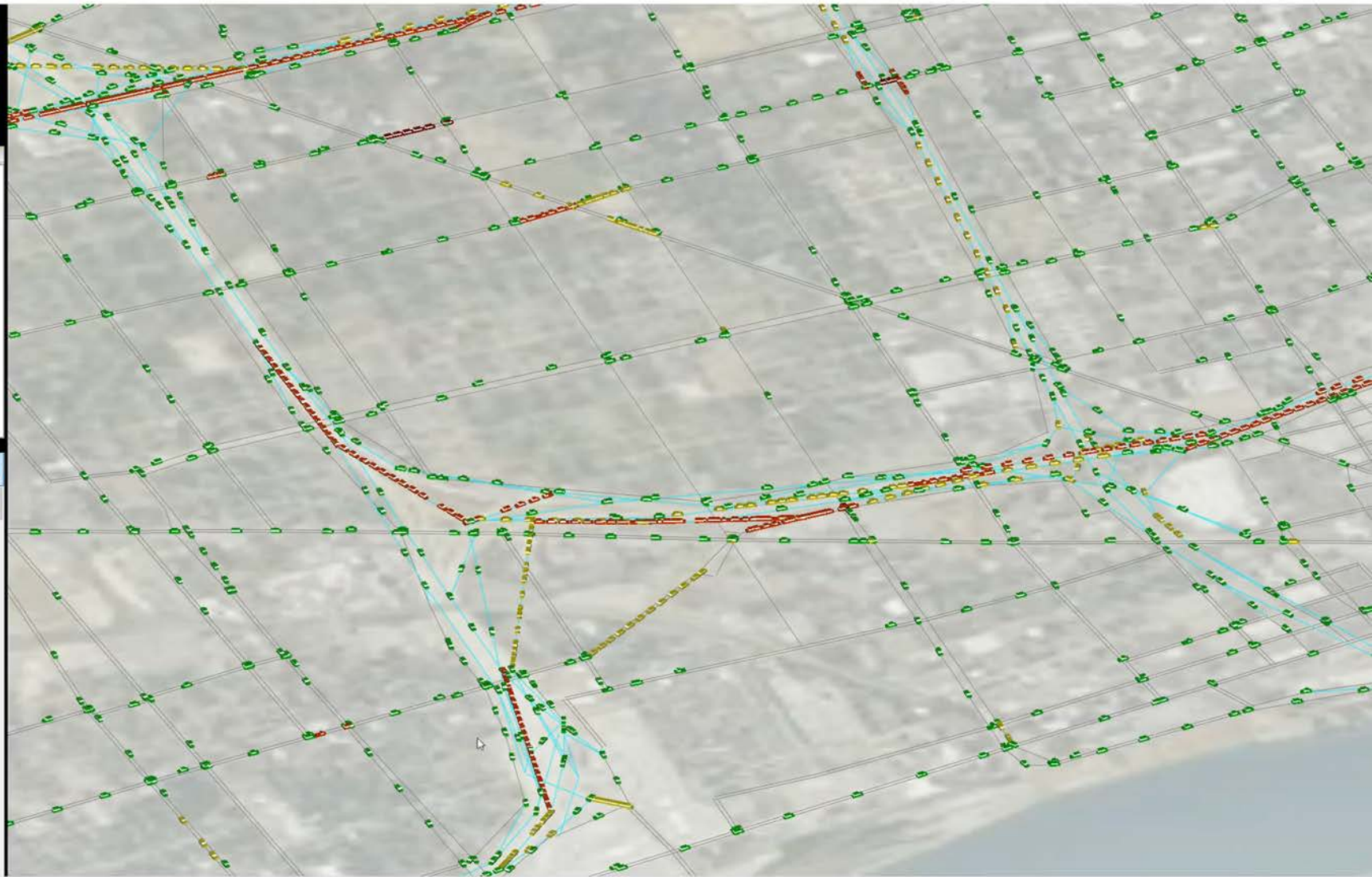
Technical Accomplishments

Comparing Baseline Model Results against Existing Data Sources

SEMCOG field counts
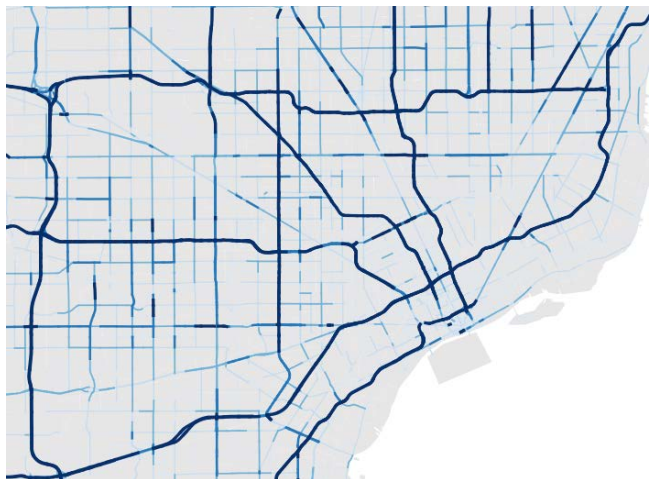
POLARIS baseline simulation

AADT
- 0 - 10000
- 10000 - 20000
- 20000 - 30000
- 30000 - 40000
- 40000 - 200000
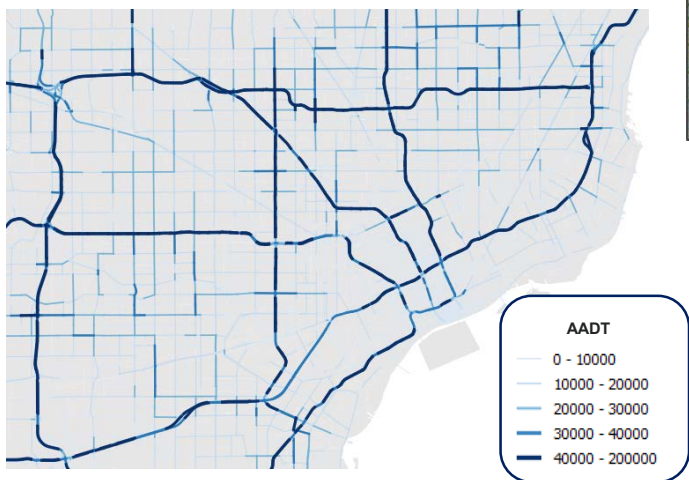
Congestion analysis by time of day
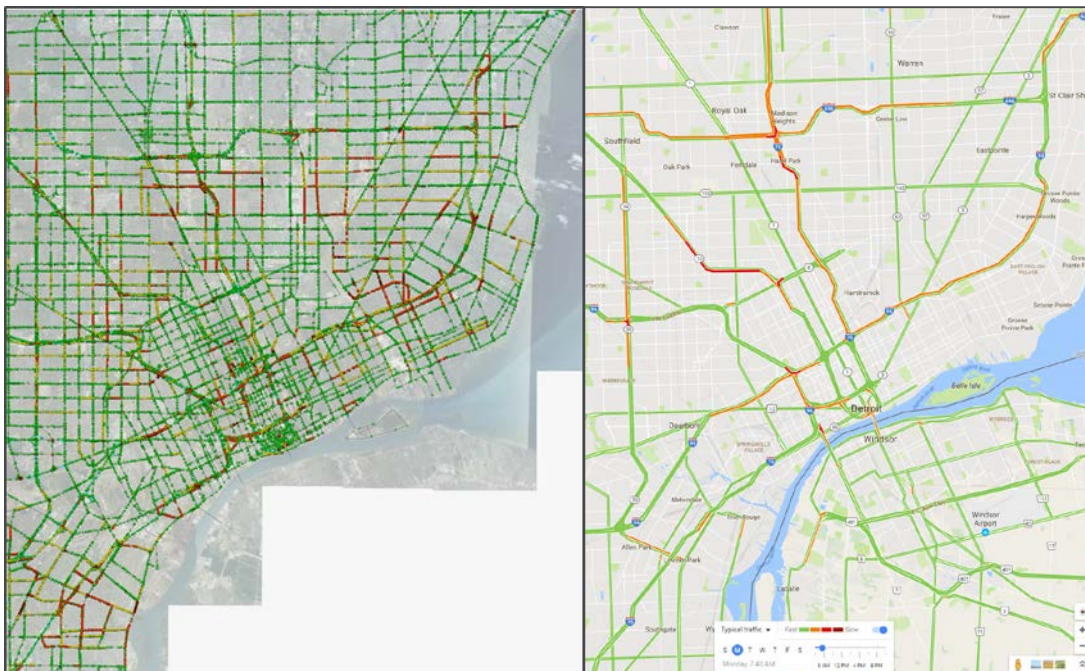
Polaris Visualizer

Google Historical Traffic

Technical Accomplishments

Scenarios Designed to Investigate the Combined Effects of Population Changes and Vehicle Technologies

- Case studies designed to independently evaluate effects of:
  - Population
  - Vehicle technology changes
  - Fleet distribution –Polaris framework vs. random from regional distribution
- Compare to reference case of 2010 population with 2015 and 2040 vehicle technologies and fleet distribution

Study	Population			Vehicle technology		Fleet distribution	
	S2010	S2040	DFC	2015	2040	Polaris	Regional
1	X			X		X	
2		X		X		X	
3			X	X		X	
4		X			X	X	
5		X			X		X
6			X		X	X	
7			X		X		X

Technical Accomplishments
Compared Baseline and Forecasts Mobility Metrics

- Substantial shifts in mobility indicators in both forecast scenarios
  - 4% increase in trips, 3% in VMT for SEMCOG case
  - Reduction of 8% in trips and 9% in VMT in DFC case
  - Overall reduction of 12% in mobility indicators for DFC vs business as usual

- Reduced travel in DFC case due to new growth in high density areas

⇒ *decreased single-occupancy auto mode use and increased transit and walk*

Mobility Indicators				
Scenario	Auto Trips	VMT	VHT	Avg. TTime
Baseline (2010)	11,237,000	98,301,600	2,832,460	15.1
SEMCOG 2040	+4.3%	+3.2%	+2.5%	-1.3%
DFC 2040	-7.9%	-8.8%	-9.4%	-1.3%

10% decrease in SOV

74% increase in transit use

95% increase in walking
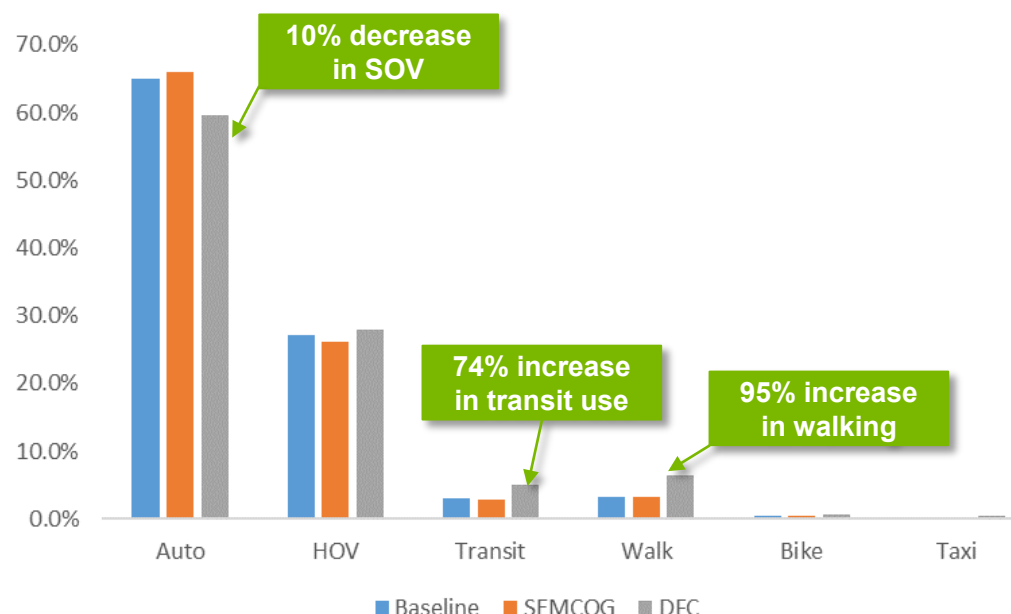
Technical Accomplishments

Substantial Shifts in Energy Use Seen when Comparing SEMCOG to DFC Forecasts

High priority development areas

Change fuel cons. (kg)

- -10000 - -1000
- -1000 - -500
- -500 - -200
- -200 - -100
- -100 - 100
- 100 - 200
- 200 - 500
- 500 - 1000
- 1000 - 10000
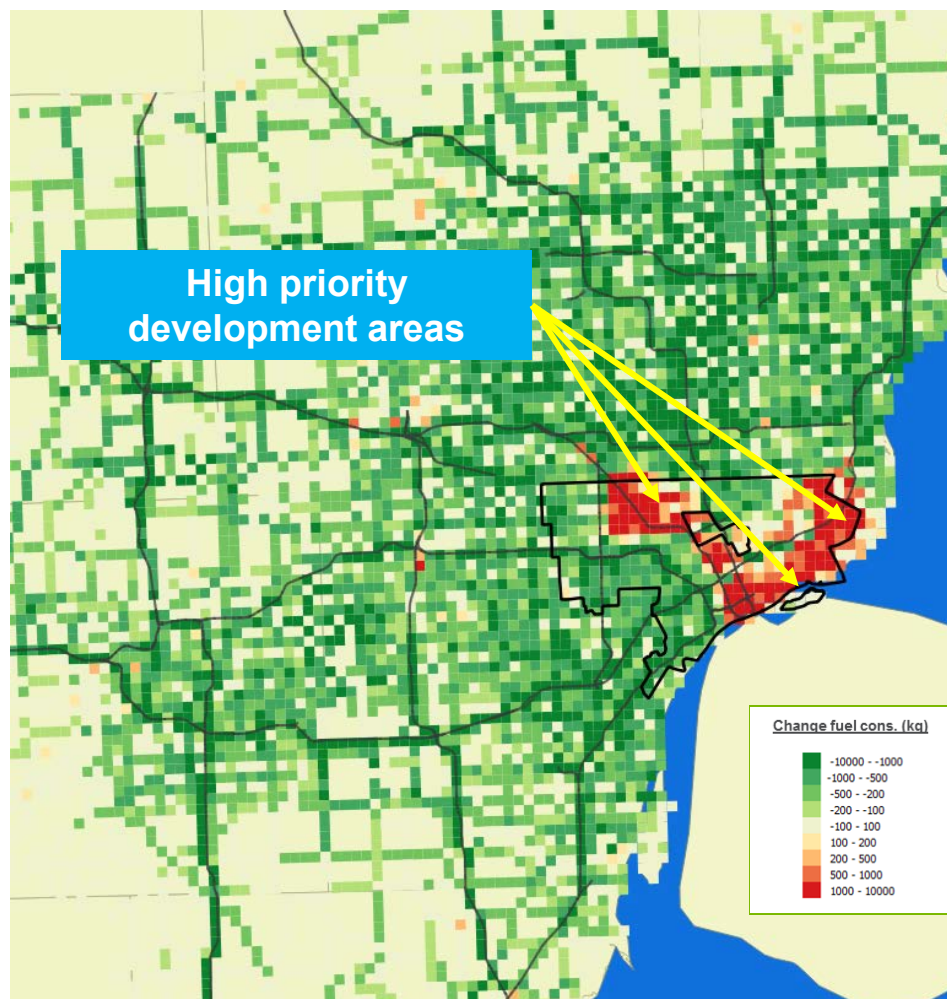
Energy consumption per 1km X 1km grid cell

- Population densification leads to clear reduction in energy use: -8.6% compared to baseline, using 2010 vehicles

- Vehicle technology has substantial impact, reducing energy use by an extra 30%

- Using disaggregate vehicle assignment vs. regional distributions gives different results
  - Lower energy use with disaggregate in SEMCOG case, but little impact on DFC

- Overall, important to consider vehicle technology and travel demand together

Scenario	Fuel Consumption by Scenario, Technology and Vehicle Distribution			
	Polaris Distribution		Regional Distribution	
	2010 Veh.	2040 Veh.	2010 Veh.	2040 Veh.
Baseline (gallons)	2,843,177	--	2,843,103	--
%Δ SEMCOG-BASE	3.0%	-29.6%	3.0%	-25.8%
%Δ DFC-BASE	-8.6%	-37.4%	-8.6%	-37.5%
%Δ DFC-SEMCOG	-11.3%	-11.2%	-11.3%	-15.7%

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Response to Previous Year Reviewers' Comments

Project was not reviewed in the past

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Partnerships and Collaborations

Detroit Housing and Revitalization: coordination and primary stakeholder, case study input
Detroit DOT: transit data provider and stakeholder

Stakeholder, scenario development, provided plan and data for analysis case study

Local MPO, data provider, engaged in meetings to discuss model development

Vehicle registration data for base year models

Remaining Challenges and Barriers

- Significant **data requirements** when building regional travel demand models
  - Require travel surveys, network inputs, population data, etc.
  - Exist in different regions in many different forms
  - Expand on the process to consume this data in standardized manner
  - Substantial additional data and effort needed for **calibration and validation**

- Forecast year model **inputs are highly uncertain** or non-existent
  - Needed to fill gaps using imputation or new model development
  - Development of the forecast models relies on many assumptions
  - Assumptions for forecast year scenarios have substantial effects on results

- **Computational time** challenges still exist, even with an efficient simulation model
  - This was a low-dimensional parametric study (i.e. 3 populations X 2 vehicle technology forecasts X 2 distribution strategies) but still takes week to run
  - Need further development in HPC utilization

- Improve the **process flow** for model runs
  - Building new scenarios and setting up analyses
  - Handoff from Polaris -> SVTrip -> Autonomie
  - Developing Amber process to facilitate

Proposed Future Research

- With baseline model developed and scenario development process in place, the Polaris-Autonomie Detroit model can be used to support multiple other use cases

- Assess potential SMART Mobility strategies to mitigate future transportation issues:
  - Coordinated transit between DDOT, Regional Transit, new light rail options, etc.
  - Smart connected multimodal corridors using new infrastructure being deployed (connected signals, transit priority, bike-share systems, real-time information provision)

- Further improvements to the baseline Polaris behavioral models:
  - Full re-estimation of behavior models (going beyond parameter calibration)
  - Calibration of network flow model against local traffic data sources

- Further linkage to MA3T – future market share forecasting rather than using base year distributions

Any proposed future work is subject to change based on funding levels

Summary

- Relevance:
  - Demonstrate the **combined effects** of population changes and vehicle technology changes on energy use for a metropolitan region

- Key achievements:
  - Fully implemented **physical model** of SE Michigan
  - Re-usable framework for distributing and updating household **vehicle fleets**
  - Simplified **population modeling** for forecast scenarios
  - Developed Detroit Future City and SEMCOG scenarios
  - Evaluation of **energy** and **mobility** impacts of various cases

- Pending funding improve model and assess SMART Mobility for Detroit:
  - Full re-estimation of behavior models
  - Calibration against local traffic data sources
  - Evaluate coordinated transit: DDOT + regional transit + lightrail…
  - Smart connected multimodal corridors: transit priority + bike share + ATIS

- Collaborated with key stakeholders:
  - Within the City of Detroit (Housing and Revitalization and DDOT) and
  - Outside (SEMCOG, DFC, NREL…)

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TECHNICAL BACK-UP SLIDES

Technical Back-Up Slides
Building the Detroit Road Network Using Polaris Editor
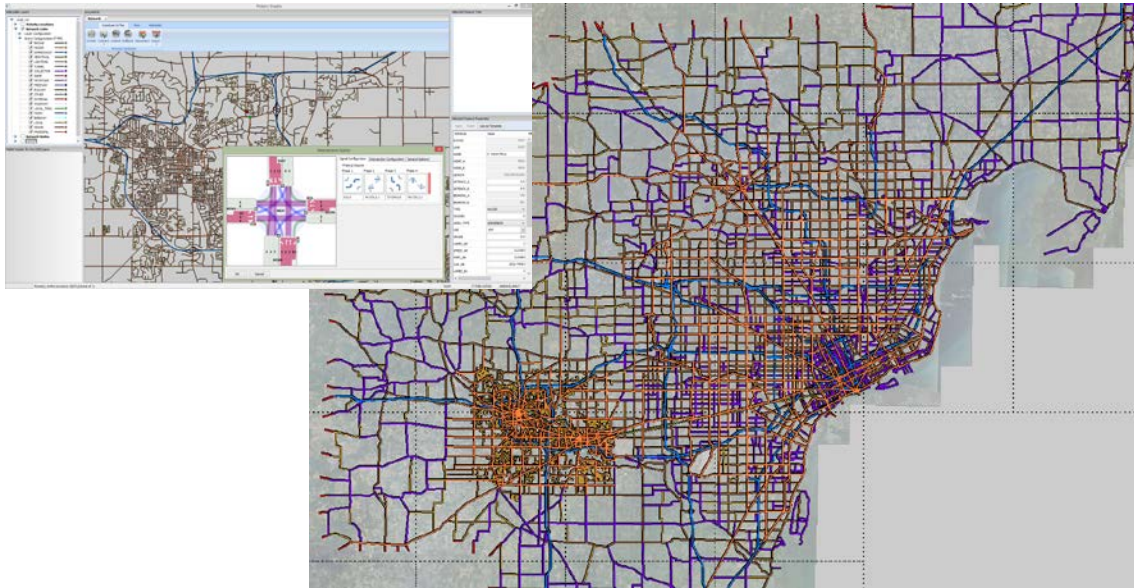
- Area: ~13,440 km^2

- Total of 28,418 links and 19,397 nodes
    - 461 road miles in AA
    - 2,526 elsewhere

- Cover entire Southeastern Michigan MPO model area.

- Roads and intersections database include types of roads, <u>number of lanes</u>, traffic control and <u>speed limits</u>.

- Network information combined through scripting, tool development and manual editing:
    - SEMCOG planning network in shapefile format, OpenStreet Map in .osm format
- Develop network validation tool to correct coding errors
    - Many errors, incorrect connectivity, missing links, turns, etc. – especially in OSM
- Python GUI interface to modify Polaris networks:
    - Add activity locations, edit links, create connectivity, add controls, …

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Technical Back-Up Slides
Land Use Transitions from DFC to POLARIS

Land use transition probability matrix based on new typology descriptions – gives the probability of any specific land-use location transitioning to a new location given the area typology (note that many types of locations assumed not to transition)

| POLARIS land use	_20Year	20year_name	New land use transition probability							
			BUSINESS	CIVIC	INDUSTRY	RECREATION	MULTI	SINGLE	AGRICULTURE	MIX
BUSINESS	GMR	Green mixed-rise	0.25	0	0	0	0.75	0	0	0
BUSINESS	GR	Green residential	0.5	0	0	0.2	0	0.3	0	0
BUSINESS	GR*	Green residential	0.5	0	0	0.1	0	0.4	0	0
BUSINESS	IE	Innovative Ecological	0.2	0	0	0.6	0	0.2	0	0
BUSINESS	IP	Innovative Productive	0.2	0	0	0	0	0	0.8	0
BUSINESS	LM	Live+Make	0.5	0	0.25	0	0.25	0	0	0
BUSINESS	MDR	Medium-density residential	0.5	0	0	0	0.5	0	0	0
INDUSTRY	CC	City center	0.25	0	0.5	0	0.25	0	0	0
INDUSTRY	DC	District Center	0.25	0	0.5	0	0.25	0	0	0
INDUSTRY	GMR	Green mixed-rise	0	0	0.25	0	0.75	0	0	0
INDUSTRY	GR	Green residential	0	0	0.5	0.2	0	0.3	0	0
INDUSTRY	GR*	Green residential	0	0	0.5	0.1	0	0.4	0	0
INDUSTRY	IE	Innovative Ecological	0	0	0.2	0.6	0	0.2	0	0
INDUSTRY	IP	Innovative Productive	0	0	0.2	0	0	0	0.8	0
INDUSTRY	LM	Live+Make	0	0	0.5	0	0.5	0	0	0
RECREATION	CC	City center	0	0	0	0.5	0.5	0	0	0
RECREATION	DC	District Center	0	0	0	0.25	0.75	0	0	0
RECREATION	GMR	Green mixed-rise	0	0	0	0.25	0.75	0	0	0
RECREATION	GR	Green residential	0	0	0	0.5	0.2	0.3	0	0
RECREATION	GR*	Green residential	0	0	0	0.5	0.2	0.3	0	0
RECREATION	LDR	Low-density residential	0	0	0	0.75	0	0.25	0	0
RECREATION	MDR	Medium-density residential	0	0	0	0.75	0.25	0	0	0
RESIDENTIAL-MULTI	GMR	Green mixed-rise	0	0	0	0.25	0.75	0	0	0
RESIDENTIAL-MULTI	GR	Green residential	0	0	0	0.2	0.4	0.4	0	0
RESIDENTIAL-MULTI	GR*	Green residential	0	0	0	0.1	0.5	0.4	0	0
RESIDENTIAL-MULTI	IE	Innovative Ecological	0	0	0	0.7	0.2	0.1	0	0
RESIDENTIAL-MULTI	IP	Innovative Productive	0	0	0.1	0	0.2	0	0.7	0
RESIDENTIAL-MULTI	LM	Live+Make	0	0	0.25	0	0.75	0	0	0
RESIDENTIAL-MULTI	NC	Neighborhood Center	0.25	0	0	0	0.5	0.25	0	0
RESIDENTIAL-SINGLE	GMR	Green mixed-rise	0	0	0	0.25	0.75	0	0	0
RESIDENTIAL-SINGLE	GR	Green residential	0	0	0	0.2	0.1	0.7	0	0
RESIDENTIAL-SINGLE	GR*	Green residential	0	0	0	0.1	0.1	0.8	0	0
RESIDENTIAL-SINGLE	IE	Innovative Ecological	0	0	0	0.7	0.1	0.2	0	0
RESIDENTIAL-SINGLE	IP	Innovative Productive	0	0	0.1	0	0	0.2	0.7	0
RESIDENTIAL-SINGLE	LM	Live+Make	0	0	0.25	0	0.75	0	0	0
RESIDENTIAL-SINGLE	MDR	Medium-density residential	0	0	0	0	0.6	0.4	0	0
RESIDENTIAL-SINGLE	NC	Neighborhood Center	0.25	0	0	0	0.5	0.25	0	0

INNOVATION PRODUCTIVE areas are landscapes of innovation where productive development types predominate. These landscapes put vacant land to productive, active uses: growing food and productive forests, reducing maintenance costs, cleaning soil, generating new knowledge, and reshaping public perceptions of vacant land. These innovative landscapes primarily include flowering fields that clean contaminated soils, research plots to test ideas, urban farms with greenhouses or cultivated forests (silviculture), and aquaculture and algae-culture facilities. A portion of these areas is devoted to blue infrastructures to manage stormwater, and ecological landscapes are also found here as a tertiary use of innovation, where working+productive development types predominate. The minimum size would be 2 acres, with some large-scale commercial sites being potentially much larger.

NEIGHBORHOOD CENTERS are vibrant mixed-use environments that are hubs for commercial, community, and recreational activities for adjacent residential areas. These neighborhoods incorporate a limited mix of commercial employment and retail uses, and support a diverse range of residential housing types from multi-family to townhouse to detached single-family. Neighborhood retail is integrated into the residential fabric in nodes or along commercial strips. Public spaces include neighborhood parks or squares, as well as integrated landscapes. Schools, recreation centers, libraries, cultural centers, or places of worship provide institutional anchors.

GREEN RESIDENTIAL areas illustrate one of the more profound ways in which Detroit may become a leader in sustainable land use, responding to neighborhood disinvestment and population loss by creating a new urban identity integrated with landscape. The Green Residential typology proposes transformed, landscape-based neighborhoods that transform Detroit's vacant and underutilized land into a canvas of green, supporting single- and multi-family residential along with community-maintained recreational spaces, productive landscapes, and blue/green infrastructure.

GREEN RESIDENTIAL TRANSITIONAL use shares the same set of strategic interventions as the Green Residential typology, but defers city systems renewal decisions until residential densities have achieved long-term stability.

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Technical Back-Up Slides

Developed Models to Convert Land Use Forecasts to Population / Employment changes

- No population or employment forecasts available for the DFC case

- Regress values for forecast year population from SEMCOG against land use

- Regress log of density against share of different land-use types, overall tract area (proxy for existing density) and area type indicators, as well as employment correction factor for new 'District Centers'
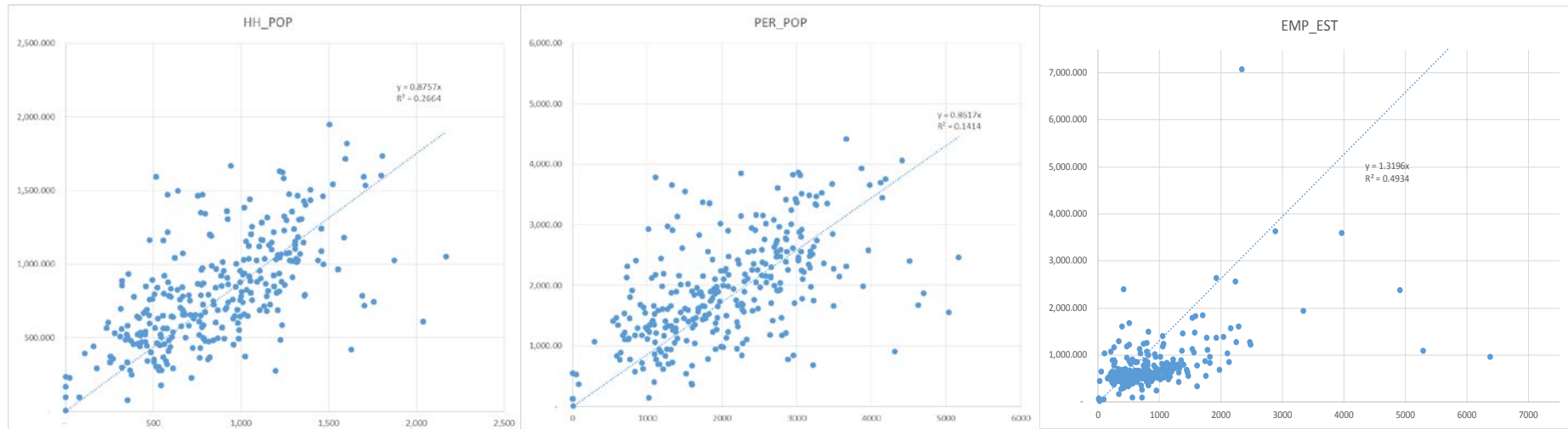

Model to apply for forecast years where we have land use changes but no population inputs

Technical Back-Up Slides

Population Synthesis Used to Generate Target Populations to Accurately Reflect Baseline and Forecast Demographics

- Generating Synthetic individuals for the simulated region
  - Using Census ACS, decennial census and MPO forecasts
  - Generate all individuals in region

- Transfer joint distribution and sample households to small geographies
  - Detailed samples (joint-distributions) given at large geographies (PUMS)
  - Marginal distributions found at small geographies (Census tract)
  - Want to transfer joint-distribution to small area then draw from samples

- Two stages:
  - IPF: generate joint distribution across several control variables from sample
  - Selection: selecting households from sample data to build population

Household level

Person level
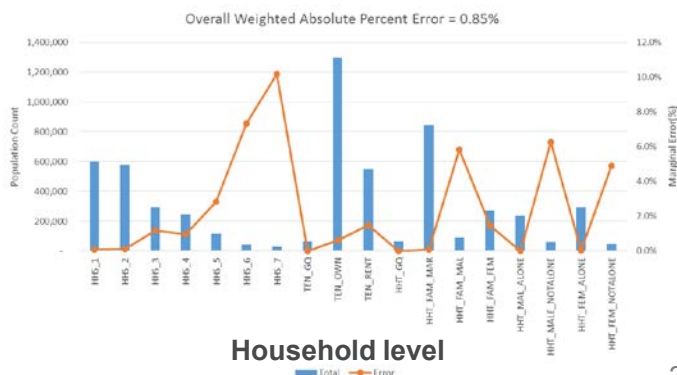
Technical Back-Up Slides

Modeling marginal household type shifts for population synthesis

- Shift in average household size due to land use change (2.4 -> 2.2 per/hh)

- Forecast change in marginal distribution of household sizes using SURE model

- Apply to Detroit census tracts

- Tune tract level population model until household size forecast and person forecast are in balance (i.e. calibrate HH density model constant =>-0.5)

	ΔHHS_1 / HH_{base}	ΔHHS_2 / HH_{base}	ΔHHS_{3-4} / HH_{base}	ΔHHS_{5+} / HH_{base}
Constant	0.032	0.017	-0.013	-0.037
(ΔHH_{tot})/ HH_{base}	0.076	0.112	0.151	0.057
$(\%HHS=i)$ x (ΔHH_{tot}) / HH_{base}	0.604	0.603	0.604	0.603
Δ JOBS/HH	0.050	0.000	-0.032	-0.018
HH DENSITY$_{base}$	-5.71E-07	–	–	5.71E-07
Δ HH DENSITY	3.19E-05	–	-2.19E-05	-1.00E-05
%SINGLE$_{base}$	–	-0.015	-0.015	0.030
%RACE_OTHER$_{base}$	-0.130	-0.096	0.057	0.168
R^2	0.68	0.80	0.88	0.55

	Household Size Distribution						
	1	2	3	4	5	6	7+
Baseline	36%	24%	15%	11%	7%	3%	3%
SEMCOG 2040	37%	26%	15%	11%	5%	3%	3%
DFC	44%	26%	12%	9%	4%	2%	2%

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